

## **Accelerator Systems Division Highlights Ending December 3, 2004**

### **ASD/JLAB: Cold Linac**

Cavity qualification is complete. Two strings remain to be assembled: assembly of H-12 is underway; H-2 will be assembled beginning next week.

All medium- $\beta$  and seven high- $\beta$  cryomodules are installed in the tunnel at SNS. The H-9 cryomodule will be shipped to ORNL next week. The H-10 and H-11 cryomodules are being assembled and are on schedule.

### **ASD/BNL: Ring**

A shipping container departed BNL on 12/02/04 with a long injection kicker magnet and stand, RF equipment (rack and power supplies) and RTBT vacuum chambers. Packed in a separate crate were two (2) HEBT momentum scraper drives and eight (8) HEBT charge exchange scraper drives.

Extraction Kicker Magnet Assemblies: An overall position discrepancy of 5 cm between mechanical installation and physics lattice dimensions of the extraction magnet assemblies was uncovered. In one case (physics lattice) a position was determined using a magnetic reference to an adjacent quad while in the second case (mechanical installation) the same position reference was made using an end plane of the steel core. (In both cases the correct reference would have been to the mechanical centerline of the reference quadrupole.) Analytical modeling is underway at BNL to confirm that this less than optimum mechanical arrangement of the kicker magnets will require the pulse forming network (PFN) power supplies to operate 1.2% lower for the upstream kicker assembly and 1.2% higher for the downstream assembly.

Both IPM vacuum chambers failed leak testing and have been returned to Shops for dismantling and repair. Multiple leaks were detected in the transition end plates; root cause appears to be porous metal plates.

Extraction Lambertson Septum (Alpha Magnetics) – A second coil has been wound; a third is underway. The first coil has been potted and tabs / junction plates have been brazed. Work on the core is progressing well at Allied, a sub-contractor to Alpha; Jim Rank addressed several non-conformance issues observed during his recent inspection/visit to Alpha. Some problems have been encountered on the circulating beam pipe where, on the ID after plating, a thin line of Ni speckles repeatedly flaked near the transition weld region. The plater has been asked to sand, clean and re-plate the transition zone.

17D224 (Pioneer Steel) – In our last weekly teleconference, Pioneer stated that the magnet core is ~30% complete; no problems, no issues. They expect to deliver to BNL around January 1<sup>st</sup>.

New bellows were welded to the (damaged) vacuum chamber of the injection septum magnet. The spare magnet will also be repaired by BNL technicians. The repaired magnet will be returned to SNS/OR on December 14.

Two doublet lifting fixtures (one for SNS/OR and one for BNL) have been Safety accepted for use.

Prior to shipment to SNS/OR, the first of two injection doublet assemblies have been moved into the mechanical testing area for final hi-pot and hydro testing. First doublet (and lifting fixture) to be shipped 12/14.

Magnetic measurements of the first 36Q85 radiation hardened quadrupole are underway. So far, so good.

### **Controls**

Participants in the ongoing database collaboration with APS met this week at SNS to review progress and establish near-term goals. Some tools are now running in the SNS “framework,” and the APS-developed “crawler” has populated much of the new “core” database with SNS data. XAL and the SNS framework were demonstrated to the APS team who will implement it at APS.

The new Java-based Archive Viewer now also runs under the SNS framework. A discussion was held (and documented!) to formulate plans for improvements to both the Archive "Engine" and the Archive Viewer.

Organized by the Controls Team, a Beckhoff Applications Engineer gave a well-attended training class on site. The class focused on the details of configuring Beckhoff remote I/O systems. The engineer also delivered some new software that seemed to help with Beckhoff driver problems we had been having. The first version of the new driver is in final test. The Modbus TCP driver has been released and appears to be working well.

Several Controls Team members are preparing abstracts for the upcoming (May 2005) Particle Accelerator Conference, either as principle or as co-authors.

AC power cabling for the CLO Central Control Room (CCR), Controls Equipment Room (CER), and Software Development Area (SDA) is nearly complete. An SRO was submitted for installation of communications cables in the same area. Designs for the CCR Target Protection System and specifications for the CCR Personnel Protection System (PPS) racks have been issued.

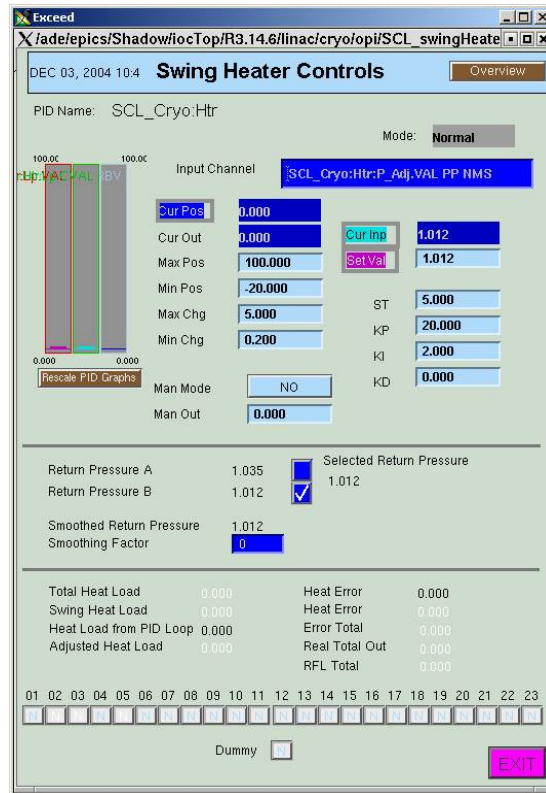
Late this week the EPICs screens and software were fully tested at BNL with the ControlLogix PLC code for all 4 Ring cavities. Only one set of HPRF equipment (and one cavity) still remains at BNL, so the I/O had to be reconfigured to test each cavity. The system worked to the satisfaction of the BNL RF group. The EPICS software, screens, and the ControlLogix PLC program have now been checked into ORNL CVS. The RF equipment at BNL will be disassembled and shipped to ORNL shortly.

Changes have been implemented in the CCL4 PLC to turn on the klystron magnets whenever the filament current is above the absolute low limit and during cold start sequence. The same change has been downloaded to the 805 MHz system in the RFTF. Time delays have been added to prevent a single low flow reading from tripping the system. A remote monitor program is running which will log flow transmitter input values which are less than 90% of the running average. By thereby determining why trips are occurring on the 805MHz system it can be determined if another program modification is required.

The DTL/CCL steering magnet application has been upgraded and is tested and working.

The final installation of MB9 vacuum control system in the third SCL vacuum rack was completed this week. Testing of this vacuum rack is to start next week. We are still on schedule to complete and sign off on test procedures for the SCL vacuum rack which is required for MB3-8 RF testing on December 15<sup>th</sup>. The next SCL HPRF IOC (SCL\_HPRF:IOC12) is now running and awaiting population (timing and utility modules, PLC and Beckhoff definitions).

Checkout of the controls and operation for the 2.1 K cold box cold compressors was completed. This final checkout had to be done after the compressors were at liquid nitrogen temperature. Problems with the motor speed sensor on one of the magnetic bearing cabinets slowed the testing. Some bent pins on one of the circuit boards caused the problem. All hardware and software associated with the operation of the 2.1 K cold box has been tested and everything seems to function properly. A new soft IOC for swing heater controls and heater sequences is now operating. All PVs on the sequence screens are now defined and giving data.



The FPGA code in the Low-Level RF Field Control Module (LLRF FCM) was modified to increase the size of its feed-forward buffer. This should result in improved performance of the Adaptive Feed-Forward (AFF) system introduced during the last run.

Both testing and further development of the LEBT Chopper controller continued this week. New state machines were developed with features for a “next generation” controller – these will be tested along with the current prototype. Materials and software for a LEBT Chopper Ethernet interface were ordered. Work also began on both hardware and software for the MEBT Chopper controller.

Problems with the chiller and water tower systems have resulted in operational problems over the past few weeks, and work is proceeding to integrate these systems more fully into the control system. Chiller and tower water PVs of interest are being archived for later analysis and alarm limits are being defined. A site wide P&ID for all cooling water systems was generated and archived data for sensors on the P&ID retrieved.

Problems with accessing power monitoring data (re-establishing links between systems that were broken and restarting processes that had stopped) via the OPC server have been fixed. Some issues will require technical support from Cutler-Hammer.

## Installation

Craft Snapshot 11/30/04

ASD productive craft workers	<b>65.0</b>
Foremen (Pd by 15% OH)	5.0
AMSI management (Pd directly)	3.0
TOTAL AMSI WORKERS	73.0
Less WBS 1.9, 1.2 etc	<b>14.0</b>
Less absent	<b>3.0</b>
TOTAL PD BY ASD/ORNL DB WPs	<b>48.0</b>

## Accelerator Physics

### Operations

Continued the Operability run, staffing the control room 24/7.

Had an OPI modified in the Front End Control Room to assist the CHL staff in the turn on.

Continue working on the SNS Integrated Operations plan, met with the working group.

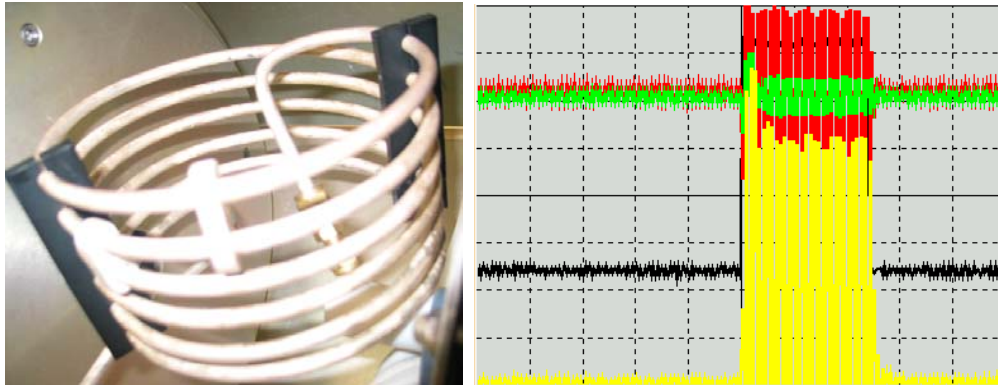
Worked with PSSO on CUB Alarms, Setpoints and operating procedures.

Worked with ASD staff on the DataStream data upload, some of which will take place the week of December 6.

### Ion Source

We have increased the ion source reliability by reconfiguring the 2 MHz matching network. The control of the tunable capacitor was modified to allow for higher capacitances. The inductance was reduced by bypassing one turn with one additional shorting clamp shown in the left picture. This reduces high voltages within the network by up to 30%. The picture on the right shows the new tune that looks as good as before.

The modification did also not change the ion beam current measured in the MEBT.



The newly installed position indicators allow for accurately controlled moves of the LEBT and ion source while delivering beam. This new feature was used to map the beam transmission through the RFQ in the absence of any steering field in lens 2. The maximum transmission was found after the LEBT and IS were lowered by 0.2 mm and moved to the right by 1 mm. The previous position was established with a laser tracker that used fiducials to align the ion source extraction aperture with the RFQ entrance aperture. The new position has lowered the horizontal emittance in the MEBT, as one can read in a related story from the physics group.



### **Survey and Alignment**

Survey & Alignment presented the most recent Linac recompression settlement findings at the Alignment Strategy meeting. Due to the ongoing recompression settlement, and the fact that CCL realignment is not feasible at this time, the height of the Linac beamline has been redefined to match the current average CCL height. Numerically, the ideal beamline height has been lowered by 0.5 mm. This change affects all components downstream of the CCL, and halts at the Linac/HEBT interface where the beamline resumes its original height.

S&A has now completed the final alignment of three warm sections in their assigned slots. The sections are 3, 4 and 5. The number 6 section has a warm section raft installed and awaiting alignment. The warm section raft for section number 7 is being pre-aligned in the LINAC tunnel. We have approximately 3 hours of work left on it before it may be moved to its final location.

In Magnet Measurement we have aligned two warm section rafts. These assemblies are now awaiting the installation of beam pipes. Two 8Q35 magnets were also fiducialized.

S&A has completed alignment of all quadrupole magnets from the Linac cage gate up to the first dipole. Today, we will continue alignment of the dipoles and vacuum chambers.

S&A performed as-built measurements of the outer reflector plug target port and the core vessel target port with respect to the beam centerline. The appropriate engineers will be sent the corresponding data upon our completion of the data processing.

S&A has received a several RTBT drawing from BNL. As a result, we are updating our data base and S&A installation drawings.

### **Mechanical**

The first SCL warm interconnect chamber has been skillfully connected by Robert Morton and Daryl Briggs. After having done lots of preparatory work for the installation and cleaning of the 3 mobile clean-rooms, it took approximately one hour to do the actual vacuum connection. Everything went smooth, as foreseen in the installation note that was approved by the committee, no big surprises, and just a few details that will have to be changed for future installations.

Friday the warm section has been isolated under vacuum, with a local Varian DUAL power supply in place for the noble-diode ion-pump. An RGA spectrum has been recorded, 1-to-100 a.m.u. Only gases present are H<sub>2</sub>, H<sub>2</sub>O, CO, CO<sub>2</sub>, traces of CH<sub>4</sub>, as normal for a UHV vacuum system. Total pressure read by the DUAL is 9.4E-8, coming down rather quickly.

Water Systems Installation

- Installation of the HEBT SB power supply cooling system was completed and put into operation.
- Installation of the HEBT tunnel magnet cooling system was completed to the first 9 - 12Q45 magnets.
- Installation of the RING SB power supply cooling system was started.
- Installation of the RING SB power supply cooling system pump upgrade continued.

Ring Systems Installation activities occurring the week ending Dec 3.

- The alignment of the HEBT Dipole chambers continued.
- The RING Injection straight section Kicker Magnets mounting anchors were installed.
- The RING RF straight section QMM / Kicker diagnostic chambers were installed.
- The RING RF straight section BCM diagnostic was installed.
- The RING arc heavy cable installation continued.
- The RTBT staged components were relocated to accommodate the upcoming crane load test.
- The appearance of a second crack under the RTBT crane rail support has resulted in an effort by PSSO to repair the cracks with an epoxy filler. A vendor will be on site next week to implement the repair.

### Electrical Group

Ben Cole has joined the group as a research mechanic. Ben was previously a contract electrical installation coordinator for SNS/AIMSI.

Since the last report, 2 Ring injector kicker power supplies (for a total of 7 of 8) and 7 Ring medium power supplies (for a total of 56 of 77) have been delivered. These deliveries included the last of the medium power supplies needed for the HEBT and these power supplies have been installed. For the ring, 7 of 8 injection kicker power supplies have been installed, and 18 of 31 ring medium power supplies have been installed (4 additional supplies are staged for installation). All ring corrector supplies have been installed. Integrated testing with magnets has started for the HEBT corrector power supplies.

Test plans for the HEBT power supplies have been reviewed and approved by SNS Electrical Safety Committee.

SCL warm section integrated magnet and power supply testing awaits installation of warm sections.

Some of the Power Supply Interfaces have failed (5 of 90 installed). The cause has been traced to improper resistors specified for the fiber optic transmitters. The transmitters run too hot and have failed prematurely. We will need to retrofit new resistors to all of the PSIs. This will take ~ .6 MY of labor and we will need to purchase surface mount assembly equipment.

Linac installation:

- SCL ME4 area – final diagnostic terminations ongoing in gallery, terminations for SCL cavities HB-1, HB-2, HB-3 ongoing in tunnel.
- SCL ME5 area – all racks installed, all cables but vacuum and diagnostic are installed, connecting racks to ac power.
- SCL ME6 area – starting cable tray installation.
- SCL ME8 area (dummy cryomodules HB-13 -23) – tray installation started, cable pulling started.

HEBT PPS cabling ongoing.

Ring RF cable pulls from Ring Service Building to Ring complete. AC hookup started. Installing vacuum racks. Cable trays installed in Diagnostics Hut.

CLO control room ac wiring pulled. Terminations are in progress. Control cabling to start next week.

Research Mechanics and technicians have performed work for the SRF Group, Mechanical Group (Magnet power supply installation in shop and for the vacuum group). They also did some work for the Experimental Facilities Division.

**HPRF**

Installation of SCL-ME5 modulator tank was completed this week. Testing of SCL-ME4 resumed after discovering improperly installed cables inside the modulator tank. SCL-ME3 cables were terminated to support the beginning of RF testing. The new PCB for the SCR units was completed and will go out for fabrication next week. Much time was spent working on and repairing the LEBT chopper pulser units. In an effort to improve reliability of these units, some modifications/enhancements to the electronics will occur next week.

SCL ME3 transmitters being brought up to heady for HV. HPRF, LLRF, epics, timing all to be checked out next week. After checkout complete all MB cryomodules can be powered along with 1st three HB cavities.

Moving equipment from 7039 to storage sheds next to RFTF underway.

Coupler conditioning should finish is a week or two.

Preparing RFTF for Thales 402.5 MHz site acceptance tests (SAT) in February.

When MB cryomodules 3-8 are cold final cavity measurements are made then waveguide piece gets installed then conditioning can begin. 5 cryomodules require final waveguide (15 waveguide pieces in all, a two man crew will need almost 2-weeks to make connections, difficult working conditions.)

HPRF Connections for SCL-ME4 checkout started with final checkout scheduled for Mid January, about 2 weeks behind schedule.

NC Systems: Supported conditioning and beam Ops.

CCL4 RF Station: Fabricated and installed phase-correcting waveguide posts. Final measurement expected next week.

Modified PLC code so that klystron magnets turn on with the filaments. This is an equipment safety feature.

SCL ME-3 Transmitters: Replaced two klystrons with water leaks to be returned to vendor for warranty repair. Completed transmitter start-up check-list. Ready to begin high power RF testing.

SCL ME-4 Transmitters: Cable terminations and HV tank preparations are underway.

RFTF: Completed processing another pair of cryo-couplers, one more pair to go. Expect completion next week. Then conversion of the test stand can begin in preparation for the testing of the replacement Thales 2.5 MW klystrons due at the end of January, 05'.

**Ring RF**

- We have made the decision to dismantle the fourth station presently at BNL and have them ship for arrival at SNS by the end of the year.
- All of the equipment presently on hand has been set in place.
- Control cable for the entire system has been pulled.
- Installation of AC power will begin on Monday.

**LLRF**

MEBT Upgrade: The recent upgrade of the MEBT was very successful. We now provide LLRF control for the entire linac with a single hardware, firmware and software platform. In response to a request from Accelerator Physics (AP) this week, we turned on adaptive feedforward beam compensation on the MEBT. The dual station configuration used in the MEBT and SCL uses the same RF Gate signal for both stations. We have developed FPGA code changes for the FCM and HPM that enable station by station control of the RF Gate signal. This allows

AP to perform ~100us time shifting of individual stations during machine tune up, as they have done previously on the warm linac. This code has been tested in the lab and will be deployed soon.

Installation: The checkout of the SCL ME-3 LLRF systems was completed recently. Installation continues on SCL ME-4 and ME-5.

FPGA Code Development: Kay Kasemir will work with Larry Doolittle at LBL next week on the FCM FPGA code upgrade. We expect Larry to visit ORNL the week of Dec 13.

### **Cryo Group**

2K Cold Box under vacuum at Liquid Nitrogen temperature

Compressors completely tested OK and also rotated at a few hertz without any problem, cooling down 4K Cold Box

Fabrication of Utubes and Dummy Cryomodule nearing completion (31<sup>st</sup> of December)

Cryomodule production and commissioning:

- H05 was received Wednesday
- H09 will be shipped next week
- H10 is on the cryomodule assembly area being completed
- H11 the 2K circuits are being welded
- H12 string will be assembled next week.
- H02 (former electropolished) all cavities have He vessels welded

Preparations continue for testing six cryomodules at 2.1 K starting around December 15, when the CHL will have cooled them. Shift schedules are being prepared together with signoff sheets. Training of testing personnel is ongoing.

### **Beam Diagnostics**